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ABSTRACT

This report describes the new system of credentialing from corporate vendors and industry/professional associations that has arisen in the information technology and telecommunications industries over the past decade. It compares this system to traditional higher education, identifying both similarities and dissimilarities, and points to some cases in which the two interact. Findings are organized in sections covering general information, examinations, course work and providers, and costs of certification. Some of the findings of the study are the following: (1) the system is global and operated in many languages; (2) the student, not the institution, is at the center of the system; (3) the system has brought competency-based education and performance assessment to a status they have never enjoyed within traditional higher education; (4) certifications replace neither experience nor degrees, and the information technology system does not pretend to be higher education; and (5) there is a critical need for more information on certification candidates and providers of courses, since the new system is now large enough to play a role in state and national planning for postsecondary education. (Contains 79 references and resources.) (KC)

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A Parallel Postsecondary Universe

The Certification System in Information Technology

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A Parallel Postsecondary Universe

The Certification System in Information Technology

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A Parallel Postsecondary Universe:
the Certification System in Information Technology

Executive Summary

This report describes a new system of credentialing that has arisen in the information technology and telecommunications industries over the past decade. It compares this system to traditional higher education, identifying both similarities and dissimilarities, and points to some cases in which the two interact. Among its findings:

General

- Both corporate vendors and industry/professional associations have created over 300 discrete certifications since the first such credential (Certified Novell Engineer, or CNE) was issued in 1989.
- Approximately 1.6 million individuals worldwide earned approximately 2.4 million information technology certifications by early 2000. Most of the certifications have been earned since 1997.
- About half of those who earned certification did so outside the United States, but we know very little else about the backgrounds and demographic characteristics of those certified. Indirect evidence, however, suggests that the age distribution of this group is dropping and that the proportion without bachelor's degrees is rising.
- About one out of eight job advertisements in information technology now mention the certifications, not as requirements for hiring, rather as a "plus" for applicants. In contrast, one out of five advertisements indicate that degrees are required.

Examinations

- Information technology certifications are earned by passing examinations administered by third parties. Three corporations administered over 3 million examinations in 140 countries in 1999.
- A large industry has arisen to prepare candidates for these examinations. This industry includes organizations (including some traditional colleges and universities) that provide course work, Web sites that offer tutorials and practice examinations, and a mass of self-study books and CD-ROMs.
- Examinations are constantly updated to reflect the current state of knowledge and practice, and to maintain certification, individuals must take the new examinations and engage in continuing professional education.

Course Work and its Providers

- While formal course work is not required to prepare for certification, the volume of offerings and providers worldwide is considerable.

- Most providers are not part of the universe that reports data on enrollments, credentials awarded, faculty and staff, etc. in the annual postsecondary data collection of the U.S. Department of Education.
- Some higher education institutions have been active participants in the certification programs, with models of collaboration ranging from linking "challenge examinations" to credits, incorporating multiple certifications into bachelor's degrees, and awarding their own certifications based on curricular packages purchased from for-profit developers.
- The entities that provide the course work are authorized to do so by the sponsor of the certification, which ensures that course content and quality of instruction meets the sponsor's standards.
- Instructors who lead the course work must themselves be certified both in content areas and in teaching and assessment practice.
- The industry has established a Council on Computing Certification to develop standards for accrediting certification programs.

Costs of Certification

- Costs vary by certification program and the extent to which candidates take formal course work from different types of providers. Examination fees range from $50 to $1,000 (the latter for hands-on laboratory performance exams), and some certifications require five or more examinations.
- The limited information we possess suggests that employers cover the costs of certification for over half of the candidates.

Summary

The summary section of this report emphasizes the major themes of the certification system and its relationship to higher education:

- The system is global and operates in many languages.
- The student, not the institution, is at the center of the system.
- The system has brought competency-based education and performance assessment to a status they have never enjoyed within traditional higher education.
- Certifications replace neither experience nor degrees, and the IT system does not pretend to be higher education.

The summary also indicates the critical need for more information on certification candidates and providers of course work, since the new system is now large enough to play a role in state and national planning for postsecondary education.

Introduction: Breaking Predictable Boundaries*

While hardly any of us who work in the traditional system of higher education noticed, a new, parallel universe of postsecondary credentials sprung up in the 1990s. One can see it now in job advertisements, on the Web, and in the financial markets: an educational and training enterprise that is transnational and competency-based, confers certifications not degrees, and exists beyond governments' notice or control. And it is much bigger than we imagine.

**1. In matters of post-compulsory schooling, we grew up and work in a world of traditional and predictable boundaries. We have universities, colleges, community colleges, and trade schools, all accredited by one recognized association or another, all granting credit hours and traditional degrees or certificates, all participating in the Federal student financial aid system, all reporting data on enrollments, degrees, staffing, salaries, and so forth to the U.S. Department of Education through the Integrated Postsecondary Education Data System (IPEDS). Even if these institutions offer virtual instruction, credit-by-examination, and other variations on the delivery of knowledge, they are still recognizable parts of the American postsecondary system.

2. The for-profit University of Phoenix is part of our comfortable world. So is the virtual Western Governors University. University College of the University of Maryland, with outposts in a dozen countries and distance delivery that reaches two dozen more, is one of us. Programs carried out by higher education institutions in concert with corporations that provide content (e.g. Novell), corporations that provide virtual delivery systems (e.g. Caliber Learning Network), and corporations that provide both (e.g. IBM), are *our* programs (Marchese, 1998). In all these cases, course work and credits as we historically have understood them are at the center of the transaction between student and program, and one party in the provision of learning offers the standard currency of higher education.

3. When national policies on post-compulsory schooling are formulated, the unit of analysis has been—and still is—the government-recognized college. From the 1960s through the 1990s, most countries assumed that these institutions would bear principal responsibility for developing new programs and new delivery systems that would serve the greater numbers of students coming forward for tertiary-level education. These policies were built on economic models of what could, would, or should happen given changes in demand.

*** Note: A shorter version of this monograph, with the title, "A Parallel Universe: Certification in the Information Technology Guild," appeared in *Change*, vol. 32 , no. 3 (May/June, 2000), pp. 20-29.**

**** Note: Paragraphs/sections are numbered to facilitate citations. See "References and Sources."**

4. Since 1972, when the Higher Education Amendments changed the fulcrum of funding in the United States from the institution to the student, the growth and change of our colleges, community colleges, and trade schools has been driven principally by demographics, and, to a lesser extent, by adjustments in financial aid formulas and practices. These are technical—and not fundamental—engines. They can be plugged into economic models. Indeed, the literature on access to higher education is full of such modeling.

5. Quite suddenly, all this seems old-industry, old-think. A new class of postsecondary providers has come on the scene—boundary-breaking and border-crossing every step of the way—to scramble institutional and governmental assumptions about the future. In higher education's fascination with the likes of for-profit degree-granting institutions such as the University of Phoenix or DeVry Institute, and with virtual degree delivery, it has been looking for challenges in the wrong direction. In a real sense, the operative economic models have been superceded by a "secular" development.

"Secular" Realities

6. When economists speak of a "secular" trend, they refer to changes that occur for reasons that lie outside classic economic models. The "secular bull market" in equities that we have witnessed since the mid-1990s occurred not because stocks were oversold and the models called for a technical upswing. Rather, the market gained momentum because the managers of a majority of equity mutual funds acknowledged a reordering of the engines of economic growth, a burst in productivity as a by-product of technological advances, and a change in the very metrics and range of valuation.

7. Simultaneously (and not coincidentally) worldwide secular economic developments changed the context for post-compulsory schooling and its interactions with the labor market (Stacey *et al*, 1999). Foremost among these developments was the emerging dominance of information technology and telecommunications as the engines of knowledge itself—let alone commerce. These two interlocking industries required a borderless system of protocols that could increase productivity in all participating economies. They also required a labor force to create, advance, and administer those protocols across national boundaries, a labor force with loyalties to occupations more than to specific organizations (Zabusky, 1997). This labor force had to meet standards of knowledge and the skillful application of knowledge that could apply in all countries and a dozen major languages. Thus a new international guild was born.

8. Thus, too, was a secular, competency-based system of certification of individuals established within this information technology guild. The student, not the institution, is the nucleus. Around that student the guild formed a network of standard setting organizations, *de facto* accrediting procedures, schools and other knowledge distribution entities, a learning support industry, and corporate agents devoted to assessment (including assessment of faculty for the schools). Weaving that net is a workforce of curriculum developers, testing specialists, academic advisors, review panels, and designers of distance education delivery.

9. Unlike traditional degrees in the U.S. (but very much like degrees in most European countries), the industry standard certifications in information technology are awarded by third party examination, with the principal examining agents operating at 5,000 sites in 140 countries and administering an estimated 3 million assessments in 25 languages in 1999. There are general field certifications, sub-field specialty certifications, requirements and electives, hierarchies of credentials analogous to the associate's, bachelors, and master's levels, and the equivalent of academic societies with their annual conventions matched to each. There are even pre-collegiate junior certifications, acting as gateways to the equivalent of college majors. As of January, 2000, the end of the first decade of its existence, this system had awarded at least 1.8 million credentials. Six months later, the count was over 1.9 million.

10. Are there "institutions" in this world of information technology (IT) certification? Yes. But few are among the 9,632 found in our national *Directory of Postsecondary Institutions* (Barbett and Lin, 1998). The majority are secular, too. They have arisen outside our usual model of postsecondary education.

Why We Should Care

From one perspective, the new world described here seems confined to the realms of continuing education and workplace training. It seems to have little to do with those of us who play instructional, administrative, custodial, policy, or analytic roles in higher education. Why should we care?

11.1 First, because our economy exhibits a voracious demand for IT workers in a wide range of occupational categories (U.S. Department of Labor, 1997), and, it is claimed, the U.S. system of education isn't producing them (ITAA, 1998). Beyond those earning formal degrees earned in IT fields, though, U.S. college students have considerable potential to fill part of the gap (Adelman, 1997), but the industry looks to the global labor market to fill its needs. That strategy has built-in limits, given public policy concerns about trade, immigration, and intellectual property.

11.2 Second, an industry in need of workers can and will offer incentives, including the reduced opportunity costs of earning credentials other than college degrees—and in a much shorter period of time than that required by degrees—that lead quickly to high starting salaries. If the certification of competence in information technology and telecommunications assumes a status like that of degrees in the global economy, students *will* respond.

11.3 Third, the emerging system of learning opportunities, assessment, and certification is now of sufficient magnitude that we cannot ignore it in institutional, state or system planning. The demographic "tidal wave" we anticipate rushing at our traditional institutions may turn into little more than a splash if students increasingly opt to participate in a system beyond our ken, and partake of higher education in patterns of attendance that elude our tracking systems (Adelman, 1999).

11.4 Lastly, some colleges and community colleges are buying into and participating in this parallel universe, mixing certifications with degree offerings and serving as agents of both vendor-specific and industry-generic IT preparation. In so doing, they are importing cultures of performance assessment and quality assurance that up to now have been foreign to most collegiate faculties. Comfortable ways of doing business may inevitably be challenged from within.

First Signs and Traces

12. This report on industry certification emerged indirectly from an exploration of community college/labor market interactions through posted criteria for hiring in entry and mid-level information technology jobs. The early phase of this study involved a content analysis of IT job ads in the Sunday "Technology Employment" classified section of *The Washington Post*. The *Post* is an extremely rich source, particularly as the Washington, DC metropolitan area now ranks in the top 10 as a market for high tech workers, though precisely *where* in the top 10 depends on who conducted the survey and how the universe of "high tech workers" was defined (Behr, 1999). Classified ads are good unobtrusive data, the kind loved by historians, biologists, and anthropologists everywhere! They are the footprints on the forest floor, far more reliable than surveys. Between April of 1998 and April of 1999, I read over 3,500 discrete job postings covering an estimated 20,000 technical positions *other than* those specifying senior status or more than five years of experience. To determine the reliability of these observations of the language used in the *Post* advertisements, another 350 job postings in the *San Jose Mercury News* (serving Silicon Valley) between February and April of 1999 were subjected to the same analysis. To determine the durability of these observations, approximately 300 job ads in *The Washington Post* during March 2000 were also examined.

12.1 The content of the advertisements was sorted into five category bins: degrees/ credentials, amount/types of experience (including job tasks and industry), specific software, programming, and operating systems expertise, general technical skills, and non-technical skills. The language of each content area was scanned for dominant and distinctive features.

12.2 As table 1 demonstrates, only 21 percent of these advertisements mentioned a formal degree as a criterion of employment. A small number of entries cited specific course work (but not degrees) in computer graphics, physics, and "higher math," implying that course work can be a proxy for competence. Some notable entries went out of their way to diminish the importance of a traditional credential with such phrases as "4 years technical experience in lieu of degree," "BS preferred but experience counts more," and "2+ years of programming experience preferred *but* [emphasis added] college grads considered." As a recruiter at a high tech career fair held in Chantilly, Va. in July 2000 remarked: "I am not going to take a $50,000 risk on some dropout tinkering with motherboards in a garage who my boss says is a genius: the degree diminishes the risk somewhat, but experience reduces it immensely because experience generates evidence of what you can do in an organization."

Table 1.—Education Specified in Postings for Entry and Mid-Level IT Positions, "Technology Employment" Section, Sunday *Washington Post*, April 1998 through April 1999

	Number	Percent
Master's Degree	13	0.4%
Master's Preferred	27	0.8
BS in CS/MIS/EE/CE	206	5.8
BS + Industry Certification	17	0.5
BA/BS Required	98	2.8
BS Preferred	47	1.3
BA or Equivalent Experience	73	2.1
Associate's in IT-Related Field	37	1.0
Sub-Baccalaureate Certificate	43	1.2
"Degree" (unspecified)	184	5.2
No Degree Mentioned	2799	78.9

13. For a position requiring fluency in HTML, Java, Perl, C++, and UNIX the applicant was asked to "Forward URLs of prior design work," and nary a word about degrees appeared. This is a true performance assessment. No resume. Send us your URL. We'll log on and observe your communications skills, your technical skills, your knowledge, your artistic sensibilities. If we are good assessors of performance, we may even make some measured inferences about your ability to discover contexts for and to solve unstructured problems.

"Multi-threaded development" was a common demonstrable competence required of these jobs: the creation of a software stage for interactions where some actors must wait, others must be notified, and the players don't all talk at the same time (see Brogden, 1999, p. 173). When one thinks carefully about it, the criteria for creating both workable URLs and the mini-dramas of programming involve some of the same kind of reasoning skills higher education says its seeks to develop regardless of major. And designing transactions in client/server environments is very much like identifying logically-related events (with no extraneous material) in many other disciplines. In fact, when degrees were mentioned in the job advertisements, the fields were not confined to computer science, management information systems, and computer/ electrical engineering. Others mentioned included music, linguistics, history, physical sciences, mathematics, museology, journalism and English (for technical writing positions). The masters of the information technology universe understand a great deal about where intellectual muscles can be developed.

14. A basic competence-matrix, one that combines "years of experience" with knowledge of both generic and specific systems and software, dominates the presentation of jobs in the classified ads. This competence-matrix, as we will see, is also embedded in the course offerings of the new secular providers, where the notion of "prerequisites" is as likely to include prior *experience* as prior coursework. The "degree structure" of some industry

certifications follows a similar routine: to progress from "Associate" to "Master" (in Cisco's certification system, the levels are labeled "Associate," "Professional," and "Expert") requires years of experience in addition to passing examinations in discrete knowledge areas. When the International Webmasters Association's "Standards of Practice" defines "knowledge" as "informed understanding of the subject matter of a member's field of practice or employment, based on education and experience," and "technical competence" as "knowledge and the skillful application of knowledge," it makes explicit what we see in the job postings. The data of table 2, drawn from analyses of the job advertisements, puts these dimensions of competence together in the area of programming languages.

Table 2.—The Competence Matrix in IT Job Postings for Entry and Mid-Level Positions: of 3,500 Ads, the Number Specifying Programming Languages

	Years of Experience				
	1 to 2	3 to 4	5	Open	**Total**
Programming Languages/Software					
C++	33	20	40	158	251
Visual C++	10	7	5	66	88
Java, Java Script	38	20	19	197	274
SQL	36	20	6	114	176
PERL	8	9	0	76	93
HTML	10	7	12	56	85
Cold Fusion	7	15	4	27	53
Other & Combinations	135	200	86	525	946
Totals:	277	298	162	1219	1966

Note: SQL=Structured Query Language, a standardized language for requesting information from a data base.

PERL=Practical Extraction and Report Language, an interpretive text processing language.

HTML=Hypertext Markup Language, the current standard authoring language for creating documents on the World Wide Web.

15. In about 40 percent of the posted jobs for early career positions, then, what the industry wants to know is not merely whether you can write Java and Java Script, but how long you have been practicing. The combination is a sign to an employer that you are ready for the next step, whether in programming, operating systems, servers, networks, or Web development.

The next step is the certification of competence, the moment at which your acquired knowledge and skills are benchmarked.

16. Beyond the type of requirements reflected in the competence matrix, the ads often cited what to me, at the time, were strange abbreviations

> "You must . . . hold (or be actively seeking) CCDA [Certified Cisco Design Associate] certification."
>
> "You should possess (or be able to achieve) CCNA [Cisco Certified Network Associate] certification with a strong desire for CCIE [Cisco Certified InterNetworking Expert]."
>
> "CNE [Certified Novell Engineer] a big plus."

While the language seems a bit hesitant, as if it were reflecting an emerging phenomenon, these are instances of the IT industry's formal certifications of competence. Some people who hold these certifications are not so hesitant, however. The signatures on more than one of the communications received in the course of researching this topic were in the form,

> "John Doe
> MCSE, Master ASE [Compaq]"

The acronyms are not puffery. They are evolving into professional markers, a reflection of the way in which the occupants of technical positions increasingly see their "expertise and contribution to the work process . . . within the professional division of labor" (Nelson and Barley, 1994, p.22)

IT Certifications: the Basic Universe

17. As Microsoft's home page for certification notes, the difference between a certificate and the courses you might take lies in the former's attestation to benchmarking. Table 3 reflects the presence of IT certifications in job postings:

Table 3.—Count of Desired Industry Certifications Specified in the Portfolio of 3,500 Information Technology Job Advertisements, April 1998-April 1999

MCSE (Microsoft Certified Systems Engineer)	96
ODBA (Oracle Database Administrator)	95
CNA (Certified Novell Administrator)	77
CNE (Certified Novell Engineer)	64
Cisco Certifications	28
Other Certifications	100

Among the "other" certifications mentioned?

ASE	Accredited Systems Engineer (Compaq)
PSS	Certified Professional Server Specialist (IBM)
RHCE	Red Hat Certified Engineer
CLP	Certified Lotus Professional Application Developer
MCSD	Microsoft Certified Solution Developer
MNS	Master of Network Science (3Com), with 5 specializations
A+	(PC support service) Computer Technology Industry Association

and dozens more. There are certifications in programming, network management, training, and telecommunications, certifications from specific vendors and generic certifications from industry associations. Christianson and Fajen's helpful 1999 guide to certifications describes nearly 300 of them (a decade earlier, then was only one, the CNE), and this universe was dated by the time Christianson and Fajen went to press! Brainbuzz.com (a site for assisting people preparing for certification examinations) listed over 350 certifications by mid-2000, and the "Certification Watch" for June 2000, marked 11 new certifications. The woods of certification are coming to resemble the forest of bachelor's and associate's degrees delivered in over 1,000 fields by over 3,000 institutions of higher education and in which (as notices in *The Chronicle of Higher Education* attest) a half-dozen trees are planted weekly.

18. Across the roughly 3,500 job advertisements, one out of eight mentioned an IT industry certification as a preferred background for employment. To garner a preliminary indicator of change, I returned to the *Washington Post* Sunday "Technology Employment" sections in March 2000, and found roughly one out of seven. Within a few years, perhaps one out of five will do so–the same ratio as we currently find for formal postsecondary credentials (though formal degrees are usually *requirements*, not enhancements).

19. This growth will come from the supply side. As Christianson and Fajen document, more than 50 major corporate vendors, IT industry associations, and large intermediary "training partners" such as Learning Tree (which reports serving 113,000 IT students) have formally established criterion-referenced standards for what it takes to perform at an optimal level in various parts of the information technology and telecommunications worlds. Another 7,500 corporate vendors with global workforces recognize these standards. When you hang out a criterion-referenced sign, you are providing a public set of educational objectives and a supply-side opportunity. In a learning society such as ours, people reach for those objectives, and employers feel free to encourage a proxy for attainment.

Some certifications thus function like degrees. Other certifications function like licenses in that they require renewal. For example, after one receives the mantel of Certified Internet Webmaster one must work at the role for two years and complete 30 hours of continuing education to qualify for *re*certification. In all Microsoft Certified Professional programs, as exams are retired and replaced, one is required to take the new assessments to remain certified.

Novell adds examinations as the state of knowledge changes, and in unmistakably uncompromising language: "All CNE certified individuals are required to pass the exam for either course 529 [Netware5 Update] or 570 [Netware5 Advanced Administration] by August 31, 2000. Failure to do so will result in loss of CNE status."

Playing by the Numbers

20. How many IT certifications have been issued? Initially, it was hard to come by the numbers because there is no central registry; and the data one can extract from various press releases, examination preparation books, and Web sites do not yield unduplicated headcounts. Most (though not all) vendors and industry associations, however, are pleased to provide the information when asked directly. Table 4 summarizes what one can obtain from them (only Microsoft provides other than rounded numbers); it *excludes* the kind of certifications offered to end-user office workers who demonstrate proficiency in software packages. The Microsoft Office User Specialist (MOUS) certification, in three levels (general, expert, and master), is the best illustration of what is excluded.

Table 4. Headcounts of Information Technology Certifications as of 2000

	Headcount	Date or Source
Microsoft Certified Professional (MCP)	521,639	June 14, 2000
Microsoft Ceretified Solutions Developer (MCSD)	27,427	June 14, 2000
Microsoft Certified Systems Engineer (MCSE)	279,745	June 14, 2000
Other Microsoft Certified Professional Programs	218,841	June 14, 2000
Certified Cisco Design Associate (CCDA)	4,000 *	C&F, 1999, p. 24
Certified Cisco Internetworking Expert (CCIE)	4,996	July 31, 2000
Other Cisco Certifications	26,000 *	Late 1999
Certified Novell Engineer (CNE)	175,000	Late 1999
Certified Novell Administrator (CNA)	370,000	Late 1999
Other Novell Certifications	18,300	Late 1999
Oracle (all certifications)	24,000 *	Late 1999
Certified Info Systems Security Professional (CISSP)	1,500	C&F, 1999, p. 46
Citrix Certified Associate (CCA)	8,000	August 1999
A+ (Computer Technology Industry Association)	150,000	November 1999
Other Computer Technology Industry Assoc Certifications	15,600 *	June 2000
Institute for Certification of Computing Professionals	50,000	July 2000
Nat. Assoc of Communic Systems Engineers (all Certifs)	18,000	February 2000
Others (Baan, Sybase, SAP, Adobe, etc.)	43,778	Martinez, 1999
TOTAL:	1,936,826	

Note: C&F = Christianson and Fajan; 1999; * = unduplicated headcount estimate.

21. The 1.9 million certifications (not people, but certifications) we know about is probably two-thirds of the iceberg, particularly as some major U.S. players (Sun, IBM, Compaq) are

not accounted for. This is a global industry, these are worldwide figures, and if Microsoft's data on MCSE's and Cisco's data on CCIE's are any indication, about half of the major certifications are awarded to individuals *outside* the United States. As for growth, consider: there were 35,000 MCSE's awarded by the fall of 1997 and 280,000 by June of 2000. For the more rarified MCSD (Microsoft Certified Solutions Developer), the numbers rose from 3,000 to over 27,000 in the same period. And during the same period, too, the number of discrete certifications available from all sponsors increased by 200 (a veritable doubling of options).

22. Is there any way of estimating an unduplicated headcount? Microsoft reported an unduplicated headcount of its own certifications at 719,129 in February 2000, or 81 percent of its total number as of that month. But that figure seems oddly high in light of surveys (Microsoft's included) that show 50 to 60 percent of the candidates walking into examination rooms already hold at least one IT certification (sometimes from another vendor). In a 1997 Gartner Group survey of 7,000 certification candidates cited by Martinez (1999), the proportion seeking their first certification had dropped to 31 percent (from 56 percent in 1994). The percentage might seem extreme, but the trend is credible.

Allow some license in light of these varying estimates, as well as the pace of growth: I will ballpark worldwide certifications at 2.5 million and unduplicated headcount at 65 percent of that, or more than a year's production of bachelor's and associate's degrees in the U.S.

23. More global and unobtrusive ways to reckon growth in *potential* certifications lie in examining the volume of offerings of courses that prepare individuals for certification—or, when available, indirect indications of actual enrollments. Even those very oblique methods underestimate activity in a field full of autodidacts and self-study materials (the Library of Congress holds 233 exam preparation books and study guides for the MCSE alone), and in certification specifications in which coursework may be recommended, but usually not required because the industry knows how much can be learned by experience and self-study. In Microsoft's 1997 salary survey of a sample of its certificate holders, 98 percent indicated self-study as a preparation method, with 91 percent using books. And in a 1998 study by the Gartner Group (cited by Martinez, 1999) 43 percent of 6,000 certification candidates indicated self-study as their primary preparation method. College course work was last on the Gartner list, but other classroom training (from the vendors themselves) was ranked much higher.

24. In an attempt to access course enrollments as a potential indicator of future certifications, I entered a query at the Cisco Web site for all course offerings by either Cisco or its training partners in the year 2000 that were part of the certification preparation sequences. The answer: "3,822. Please narrow your search!" If only five people show up to each class, these 3,822 offerings could prompt nearly 20,000 cases of course taking.

25. In a more finite illustration, consider the offerings for a five-day (40 hour) course in Advanced Cisco Router Configuration, *one* of the core courses leading into CCNA (Cisco Certified Network Associate) certification. During the two-week period Jan. 23-Feb. 3, 2000,

this course was offered at 75 locations in 20 countries on four continents and in ten languages (English, Chinese, Japanese, German, French, Italian, Spanish, Portuguese, Dutch, and Turkish)—and in all cases by providers *other than* traditional institutions of postsecondary education. The introductory CCNA course, a 40-hour Web-based production, is delivered continuously in English from 12 servers in the U.S., UK, Germany, Austria, Russia, and Brazil, and by Cisco "training partners" Global Knowledge, Ascolta Training, Getronics UK, Mentor Technologies Group, Azlan Limited, Multireded Informatica, Sequoia Networks, and others. None of these partners was in the Integrated Postsecondary Education Data System (IPEDS) as of 1998. Because these training partners exist outside government reporting systems, we have no idea how many people actually attended these course offerings.

26. Oracle provides a rare window into enrollment volume. When one clicks on the registration page for an Oracle course offered directly by Oracle, and indicates preferred geographic region and time period, the response is a listing of sites, dates, and number of seats still open. For example, in the month beginning February 21, 2000, and for the five-day foundations course, Introduction to Oracle: SQL [Structured Query Language], 75 classes were offered in the continental United States. As of February 17, eight of those classes were sold out, and another 19 had five or fewer seats open. Assuming a mean class size of 20 and subtracting the listed open seats, 780 people were enrolled for that one course during that one month period. Annualized enrollment: 9,360. Would all these people pass the Oracle SQL test and proceed on toward certification? No. But the numbers give us an idea of demand for this knowledge.

Some of Cisco's training partners in countries outside the U.S. present the same type of window. Between May and August of 2000, the Softnet Learning Center in Buenos Aires, Argentina offered 30 courses on 11 Cisco topics with a capacity of 12-16 students per course. As of May 24, 172 seats had been filled and two courses (both given in May) were closed. Latin America is now the fastest growing Internet market, and requires a home-grown workforce to serve the infrastructure. Seats such as these will be claimed.

The Providers

27. Who provides preparation for industry certifications? And what are the quality assurance mechanisms? These are critical questions for the fastest growing information economies worldwide. The certifications are portable, and the providers must be recognized across borders by common standards.

28. Last year, an enterprising reporter for the *Washington Post Magazine* toured traditional postsecondary institutions in the Washington, DC metropolitan area to see who was providing programs that *might* lead to the various IT certifications (Taylor, 1999). She found that the community colleges and the less-than-4-year proprietary schools carried the largest proportion of *potential* certificate candidates, though these institutions were not very likely to deliver instruction over the Internet. At the same time, the public 4-year extensions (dominated by the

University of Maryland's University College) registered the highest number or both degree candidates (in Computer and Information Sciences) and on-line offerings. But without course content analyses we can only guess who, among those attending traditional postsecondary institutions, might be preparing for industry certification.

29. Beyond the list of institutions the *Post* reporter presented, though, I found another 12 regional commercial providers through advertisements, 10 on-line providers and international technology training firms such as Global Knowledge, and eight education divisions of major vendors that offered classroom instruction in the Washington area. Collectively, the added group presented *explicit* preparatory curricula for no less than 37 vendor and industry association IT certifications. Without them, the count of providers has not even begun.

These "secular" providers are distinguished from colleges, universities, community colleges and trade schools by:

29.1 *Operating outside Title IV of the Higher Education Amendments and the Integrated Postsecondary Education Data System (IPEDS).* To repeat: they do not participate in the federal student financial aid and reporting systems. We thus know little about their students. Furthermore, the type of background information they collect from students is not the type one finds in IPEDS-derived tables in the annual *Digest of Education Statistics.*

As a new student to Sun Microsystems Education Services, for example, you are asked only for name, social security/passport number, address, phone numbers, employer, and profession. If you fill out Sun's personalized training needs survey, you add job title, job description, prior certifications, desired certifications, a self assessment of your strengths and weaknesses in information technology, and a set of ratings on what you believe to be most important to you and your organization's success. No race, sex, age, prior schooling, or any similar questions we ask under the IPEDS roof. The international IT guild cares most about personal and organizational competence. The registration form is the same in every country, every language.

29.2 *Operating outside the formal postsecondary education accreditation system.* They are a-accredited. Up to this point, accreditation has not been in their mission or concept of quality assurance. Instead, the primary vendors (Microsoft, Sun, Cisco, Novell, and so forth) or industry associations (International Information Systems Security Consortium, the National Association of Communications System Engineers) establish standards, and themselves act as *de facto* accrediting bodies when they authorize other entities to serve as "training partners" or "authorized education centers." In August 1998, for example, Sun Microsystems entered into an agreement with New Horizons Computer Learning Centers under which 25 New Horizons locations offered Sun-developed Java courseware from its certification curriculum, and, critically, agreed that New Horizons instructors would train for, receive, and maintain certification by Sun (an arrangement illustrating the centrality of teaching quality in the IT certification world). In July of 2000, 24 of those locations were still Sun-authorized.

When the IT certification system turns to something resembling accreditation, it will be carried out within its own borders. This development is already underway, with the establishment of a Council on Computing Certification in May 2000 (see sections 62 and 63 below).

29.3 *Operating with a faculty judged solely on the quality of its teaching ("quality" including currency and depth of subject matter knowledge).* Instructors at these "training partners" are certified as knowledgeable in the curriculum and as skilled in instruction in ways that no traditional accrediting body would demand. The Chauncey Group, a subsidiary of ETS, provides the principal generic certification of technical instructors, the CTT (Certified Technical Trainer), through both a computer-based examination and a performance assessment video-tape; and there is a growing business in workshops and boot camps to prepare candidates for the CTT. The major vendors also offer separate certifications for instructors, with an expectation that the instructor must first hold one or more of the content certifications offered by the vendor (in 1998, for example, 55 percent of the Microsoft Certified Trainers [MCT] also held the MCSE). The evaluation of these individuals does not include research activities, community service, or participation in institutional governance. Teaching is everything.

29.4 *Operating under different criteria for "admission" than traditional postsecondary institutions.* These criteria range widely, but none of them involve the ritual presentation of high school records and test scores required (even if they are not used) by colleges, community colleges, universities and proprietary degree-granting institutions. Unless participation is restricted to employees of an organization or agency, the secular world is largely an open door world. There are exceptions, of course.

If one wishes to work toward a UNIX certification (UNIX system certifications come under many guises) and takes the preparatory program at the U.S. Department of Agriculture's "Graduate School," one begins with a 5-day (7 hours per day) Introduction to UNIX System V. The prerequisite? "Familiarity and confidence with computer hardware and software concepts." Period! In contrast, CyberLearning offers an 80-hour fast-track MCSE program restricted to "experienced networking professionals and university IT and Engineering seniors and graduates only" and a 172-hour MCSE program for which "college degree [is] desirable."

If one starts out on the path toward the generic Certified Internet Webmaster (CIW) designation through prosofttraining.com, and wishes to skip the 5-day Foundations course and move directly into the coursework for CIW specialist certifications such as those for Site Designer or Enterprise Developer, one can present a passing score on CompTIA's i-NET examination instead. In other words, concrete evidence of one level of competence becomes the generic form of prerequisite in this guild, and the equivalent of "credit by examination," at least at the introductory course level, is becoming a more common practice.

30. Some of the seculars are for-profit; some are divisions of corporations and public agencies that charge tuition and are expected—at a minimum—to break even. What kinds of organizations fall under the umbrella of these "seculars"?

31. Public Agencies: I have taken courses at two of these: the Center for Information Technology of the National Institutes of Health and the USDA Graduate School. The former restricts enrollment to the NIH "computing community" (federal employees, contractors, guest workers, visiting scientists, research collaborators and their staffs). "Admission" is by recommendation and support of the student's employing agency, i.e. one does not need a degree (or even a high school diploma) to study mainframe or statistical package programming at NIH. In 1998, there were approximately 11,000 applications, 10,000 acceptances, and 6,200 actual registrations for CIT courses. The seat time for these courses lasts anywhere from 2 hours (Introduction to Disaster Recovery) to 35 hours (the basic C programming course). If you sought to master the SAS statistical program, you would be in the computer lab classroom for four courses and 42 hours, plus 3-4 hours of practice for every classroom hour. Despite the demands of course work—and the quality of instruction from a staff that is largely volunteer—CIT has no relationship to the formal higher education sector. None of the curriculum is submitted to the American Council on Education's College Credit Recommendation Service for college credits or Continuing Education Unit (CEU) equivalency.

32. The USDA Graduate School has been around for a long time, and its presence in delivering preparation for industry certification in information technology fields is not insignificant: in 1998, its Center for Applied Technology clocked 12,644 registrations (again, not an unduplicated headcount, and of which 2,061 were in courses that prepare one for IT certifications), including those of employees of federal agencies, states, cities, federal contractors, international organizations, other countries—and walk-ins from everywhere, including high school and college students. While the USDA Graduate School offers its own certificate programs in business, computer and information systems management, and languages other than English, students can enroll for individual courses without committing to a program. CEUs are awarded on request, and college credit arrangements are brokered by ACE's College Credit Recommendation Service.

33. Primary Vendors: These are the Microsofts, Oracles, Novells, and Ciscos. In addition to designing the curricula and writing the examination specifications, they are all in the direct-provision business. Sun Microsystems, for example, does a lot more than deliver on-line ergonomics instruction to its employees through its Intranet Sun Microsystems University. Its Sun Educational Services division offers over 200 courses in classroom, Web-based, and CD modes, and with no restrictions on who can register. Pick your country! A Chinese menu pops up, or a listing of *las fechas y horarios* for the course, "*Desarrollo de componentes* JavaBeans" in Mexico City. France? Register by December 1 and "*un coffret de 3 bouteilles de Champagne Cuvée An 2000 vous sera remis!*" In Beijing, Buenos Aires, or Boston there is a Sun office with trained and certified employees who serve as instructors at either the office itself or rented locations.

34. Training-Partners. This universe includes large multi-national for-profits such as Global Knowledge, Azlan and New Horizons, and local for-profits in other countries, e.g. Suntek Information Systems in Korea and Dr. Materna in Germany. None of these are subject

to regulation under the Higher Education Amendments, and given their global operations, they obviously prefer to stay that way. Some of them are not in the direct provision trade, rather specialize in reconfiguring curriculum for on-line or CD-based instruction. They thus function as intermediary vendors.

35. As an example of intermediary reconfiguration, NETg provides 700 on-line modules for IT training programs at the National Institutes of Health, including eight devoted to the background curriculum for Microsoft Certified Solutions Developer (MCSD) certification, 28 that will set you up for Cisco certification exams, over 100 co-developed with Oracle Education (the majority devoted to database administration), and an "Internet Masters Series" (HTML, TCP/IP, JavaScript, web site security and administration) developed with Netscape. NIH bought 600 licenses for this collection, augmented by a circulating library of self-study guides, a measure of expected volume of use.

36. SmartForce, another "e-learning" secular, takes the concept several steps further by adding on-line mentors to its on-line courses, a library of laboratory simulations, threaded discussion forums on particular vendor products or generic developments in the IT industry, and the chance to interact with guest speakers on a pay-per-view basis.

37. Some training partners have developed their own certification programs, but the certificates awarded, like those of community colleges and colleges, do not hold the same status as those granted by vendors and industry associations. Learning Tree International, for example, will dub one a "certified professional" in Cisco Router or Oracle7 Database Administrator on completion of course work (minimum of 22 days and $4,500 for Cisco; 19–24 days and $4500 for Oracle) and passing allied examinations (Learning Tree, 1999). These certifications are recommended for 10 college credits by ACE's College Credit Recommendation Service, but they do not mean either that a successful candidate is certified by Cisco or Oracle or that a particular college will award 10 credits.

38. "Secondary" vendors. "Secondary" does not imply a small corporation, rather a limited presence in the IT certification world. Citrix Systems, a major producer of software for server-based computing, grants the Citrix Certified Administrator (CCA) with two tracks. Preparatory course work is available through "Citrix Authorized Learning Centers" (CALCs), e.g., the secular Emergent Online, of Reston, Va., will prepare students for the MetaFrame Administration track in a 4-day course offered 13 times between October 1999 and June of 2000, for $1,895. New Horizons will perform a similar service in Atlanta, Boston, Charlotte, New York City, San Antonio, San Francisco, and St. Louis. As of August 1999, approximately 8,000 CCAs had been awarded (see table 4).

39. The secondary vendors seem to be more subject to rationalization in the industry than the major vendors. For example, Christianson and Fajan indicate that Open Market, an e-business application software developer, offered a certification called "Folio 4 Certified Infobase Engineer." A search of Open Market's website in January of 2000 yielded no reference to this

certification, let alone to Folio. A trip around the Web revealed that by the time Christianson and Fajan published, Folio software products had been acquired by a specialist in Internet publishing technology called NextPage, and that NextPage also assumed control of Open Market's "LivePublish" software. While training courses in the use of all these products were offered, the certification had disappeared from the radar screen.

Banyan Worldwide (formerly Banyan Systems) had issued approximately 900 certifications in network administration and design by the end of 1998, and less than two years later, discontinued its network operations. No doubt those certified will seek other credentials in the networking field. This is an industry that doesn't sit still long enough to be measured. It is also an industry in which technical professionals don't sit still, either.

40. Corporate Universities: By the most recent count of their informal association, the Corporate University Xchange, there are over 1,000 such entities, all but a handful (for example, the Tennessee Valley Authority University) private. Unless they are IT principles themselves, e.g. Sun Microsystems, they are not in our universe, principally because (a) most of them outsource their IT training, and (b) that training appears to be limited to end office user software. Even Motorola University does not directly offer preparation for IT certifications.

Data on curriculum, enrollments, and other traditional measures are very generalized in the corporate university world. We get lots of information on structure, philosophy, development, and organizational processes (Meister, 1998), but very little on anything else. We get pert-charts, not syllabi or sample examinations such as those offered by IT "training providers" and primary certification vendors at their Web sites. In its IT certification role, the education and training service division of IBM, for example, sets out 17 certification "road maps" similar to curricular advisories in highly structured college majors, along with detailed course outlines and sample examination questions. The typical corporate university seems to regard such information as proprietary.

What It Costs

41. Where there is a market, there is a business, and industry certification in IT is no exception. It doesn't come free, and the costs of preparation for certification vary widely by the source and delivery method of training, and the country in which the training takes place. Table 5 indicates the typical range of both advertised (by the for-profits) and computed (from catalogs) tuition for instructor-led preparation programs in the Washington, DC metropolitan area. The ranges exclude out-lyers (for example, there is one secular provider that offers different forms of MCSE preparation with prices from $3,950 to $7,950 depending on a student's background and sponsorship).

Table 5.—Range of Advertised and Computed Tuition for Selected IT Certification Preparation Programs at Both Traditional Postsecondary and Secular Providers in the Washington, DC Metropolitan Area, 1999

Certification	Advertised* Tuition Range	Computed** Tuition Range
A+	$500-700	$800-1200
MCSE	1400-2700	1600-6500
CCNA	1000-1750	1600-6500
ODBA	1300-1600	1500-4000
Web Developer	1500-2500	1800-4500

* In the Sunday *Washington Post* "Technology Employment" section.
**Capped at 10 credits for any certification preparation program, since 10 seems to be the standard recommendation for IT certification packages by ACE's Credit Recommendation Service.

42. These estimates are considerably lower than what it would cost you, starting from scratch, to acquire the requisite knowledge and skills prior to a special certification preparation program. A 10-day instructor-led first course in Java, direct from the source (Sun Microsystems), is priced at $1,600; a 5-day Java2 course for those who have either passed the introductory course or who can write basic programs in C or C++ is priced at $2,000 in instructor-led format or $1,000 on a self-paced CD-ROM. There are three more courses in the foundation Java sequence when you take it through Sun. The bottom line is about $7,500 (and that's cheap compared with Martinez' high-end estimate of *tabula rasa*-to-Certified Internet Webmaster at $20,330, including examination fees, self-study manuals and CDs).

43. In contrast, the Ziff-Davis on-line ZD University/SmartPlanet offers 23 self-study Java modules for a total of $658.90; the on-line SmartForce offers 15 Java modules (that it estimates take four hours each to complete) for a total of $1,875; and at Learning Tree one can apply a $4,995 four-course training packet to a 17-day instructor-lead Java sequence that can be worth nine college credits through ACE's service.

Do you get what you pay for? Unlike such questions in higher education, the variables one would array in an evaluation include job experience, the nature and intensity of self-study, prior formal course work, and the usual intangibles involved in determining the worth of a class-based experience. There is no clear answer because the populations are inaccessible (one cannot conduct research or evaluations in the Parallel Universe in the same ways as are available in the traditional higher education sector).

44. Financial aid in the IT certification preparation world is available principally in two forms. First and foremost, by employer sponsorship. In 1999, Novell surveyed 135 North American companies that employed Novell-certified staff and found mean per head direct sponsorship

costs (training classes, travel, testing) of $3,121 and indirect costs (lost employee time) of $1,933. Microsoft's 1997 salary survey of its professional certificate holders revealed that employers picked up the full preparation tab for 57 percent of the survey respondents (but a third of the respondents had footed the whole bill themselves). Despite year-to-year volatility in this survey's reported mean costs of certification (instruction, examination fees, books, tutorial CDs, etc.), the proportion of respondents reporting "full-boat support" from employers has been consistently in the 50-60 percent range. But these are limited hints: no one is tracking the full universe of certification preparation in terms of tuition reimbursement or contract learning paid directly by employers to providers. Since employers in other countries are included among the sponsors, and since some of the certifications originate in other countries (SAP in Germany; Baan in the Netherlands), estimates are even more elusive. The National Center for Education Statistics' National Household Education Survey is insufficiently detailed to get at this information for U.S. citizens.

The second potential source of support, in the U.S., lies in the new Hope and Lifetime Learning tax credits, but it will be some years before we know precisely who has used these tax credits and for what.

Certification Agents: the Testing Companies

45. The international guild system of information technology requires intermediary agents for certification. There are three testing companies that play major roles: Prometric (recently acquired from Sylvan Learning Systems by Thomson Corporation of Canada for $775 million), CatGlobal (a division of Houghton-Mifflin), and Virtual University Enterprises (VUE, a division of National Computer Systems). They are in the business of testing competence from everything from PowerPoint to C++ to the elements of the Citrix CCA and those of the major industry-certifications (MCSE, ODBA, etc.).

46. The global accessibility of these companies is stunning. Prometric operates about 2,500 testing centers in 140 countries. VUE has nearly 1500 locations, including 20 in Mexico, 28 in Russia, 23 in Brazil, 19 in South Africa, 50 in China, and others in Senegal, Kenya, Oman, Namibia, Bangladesh, Jamaica, Angola, Albania, and Honduras—among other places. CatGlobal offers wholly on-line computer-based testing from servers in 16 countries, and takes mobile testing centers to vendor expositions (in 1999, it administered 2,600 certification exams for Lotus at European expositions alone). Some of these testing "centers"are located at the sites of "training partners," presumably for convenience, and some are free-standing.

Because most of the assessments are delivered by computer on a daily basis, and because the candidate encounters a randomized selection of prompts from an item pool, test security standards meet the requirements of any client (vendor or industry association). An organization that wishes to establish itself as an authorized testing center for any of these corporations must undergo comprehensive and rigorous evaluation, particularly on test security and proctoring issues.

47. These organizations are key to any would-be accounting system of industry certification. Nobody else has as comprehensive knowledge of how many students attempt to pass which certifications, how many actually pass, and the distribution of attempts and successes by country in which the testing takes place and the national origin of the test-takers. But because the universe of testing companies is an oligopoly, they all regard this type of information as proprietary.

48. The testing, of course, is not free. A given certification may require as many as eight or nine examinations, the fees for each of which range from $50 to $250 (lower if the examinations come from an industry association and you are a member of that association). In CompTIA's pricing scheme, the fee to an employer falls with the volume of employees taking the examination. Pricing of examinations outside the U.S. varies widely by world region and vendor. For performance assessments with hands-on laboratories and simulations, the prospective examinee should count on $1,000. If one completes assessments on any three tracks of the Cisco Certified Internetworking Expert program, each of which requires both a paper examination and a laboratory performance, the total examination fee bill comes to $3,300.

The Assessments: Think You Can Pass?

49. What kind of examinations are these? First, they all have cut-scores. Similar to licensure rules in law, medicine, architecture, and nursing, this is a "no pass/no play" world, though "no play" in this case means only that one does not have access to the higher salaries and the support services of the guild that certification brings. Like the Bar exams, too, one may retake the certification tests, with an appropriate wait between test administrations.

Second, the formats of the examinations range from 45–120 minute restricted response (multiple-choice, identification, one *best* correct answer, 2/3/4 correct answers), to restricted-response adaptive modes (that stop the testing process at the point in the adaptive curve at which a passing score could be predicted at a 95 percent confidence level), constructed response (e.g. drag and drop), and "essays" (e.g. "Write a program in X to do Y" or "Write a technical report/press release explaining M to audience N), to three-hour simulations, scenarios with "select-and-place" items, and case studies involving performance benchmarks.

Even within restricted response formats, some examinations are very creative. Cisco's Certified Design Associate (CCDA) examination, for example, presents stories about organizations that require a wide area network (WAN), and a combination of drag-and-drop, identification, and one best answer questions require the candidate to apply design knowledge in the context of the stories.

50. The Red Hat Certified Engineer Exam is a six-hour laboratory affair, including two and one-half hours performing an installation and configuration of a system, and two and one-half hours debugging system problems. A core Linux operating system firm, Red Hat was the only vendor-certifier I found that indicated passing rates on examinations: 60 percent for the

performance-based Red Hat Certified Engineer exam, on which the cut-score is 80. As table 6 demonstrates, 80 is at the high end of passing scores on IT certification examinations.

Table 6.—Passing (cut) scores on a sample of certification examinations in information technology

Red Hat Certified Engineer	80
Certified UNIX System Administrator	80
Cisco Certified Internetworking Expert, Lab Exam	80
Certified Internet Webmaster	75
Sun Certified Architect	75
Disaster Recovery Institute International Certifications	75
BAAN Basic and Advanced	75
Master of Network Science (3Com)	70
Certified Information Systems Security Professional	70
Sun Network Administrator	70
Cisco Certified Internetworking Expert, Paper Exam	65

Sources: Christianson & Fajen, 1999; Martinez, 1999

51. The most demanding certification is probably the Cisco Certified Internetworking Expert (CCIE) assessment which, in addition to a two-hour written exam, requires a two-*day* lab exam that "pits the candidate against difficult build, break, and restore scenarios." Those in higher education who talk glibly about performance assessment don't really know what it means until they are up against the CCIE. On the Web site for current and prospective Cisco certified experts, one student advised others to work through the Internetwork Troubleshooting and Internetwork Design examinations before "attacking the real monster, the CCIE."

52. As in the case of high-stakes gateway examinations in the traditional higher education system, a considerable industry has arisen to assist prospective IT certification holders prepare for the examinations. Exclusive of the coursework provided by the vendors, industry associations, training-partners, and postsecondary institutions, a massive amount of printed exam preparation manuals, self-study CDs, and dedicated Web sites (certifyexpress.com, selftrain.com, exampractice.com, gocertify.com, cramsession.com, IT2002.com, netcraftonline,com, and others) form the core of support. The user should verify the credentials of the site. An on-line service that sells flowers and health advice in addition to certification preparation is probably one to avoid.

Unlike the competitive environment for access to elite undergraduate institutions or to "top" law and medical schools, the spirit of the IT certification industry involves cooperation and sharing. The most revealing indication of this phenomenon is the "braindump," a Web site

at which prospective examinees seek—and others provide—sample questions and problems that will help them prepare. Here are two typical exchanges:

? I am preparing for the Sun Certified Programmer. Please send questions as many as you have . . .also tell me about recommended reading material.

▸ What will happen if you compile/run the following code?

1: public class Q21 2: {3: int maxElements; 4: 5: void Q21() 6: {7:maxElements=100; 8:System.out.printIn (maxElements); 9: } 10: 11: Q21(int i) 12: {13: maxElements=i; 14: System.out,printIn(maxElements); 15: } 16: 17: public static void main(String[] args) 18: {19:Q21 a=new Q21(); 20: Q21(999); 21: } 22: }

Think about initialization [of variables], compilation errors, print output.

? Hi friends. I plan to write the Sun Java2 Certification. Please send brain dumps, related web sites, question papers. . .

▸ What will be the output [of the following]?

public class Test {public static void main(String args[] { StringBuffer a=new StringBuffer("One"); StringBuffer b= new StringBuffer("Two"); Test.swap(a,b); System.out.printIn("a is "+a="\nb is "+b);} static void swap (StringBuffer a, StringBufferb) {a.append("more"); b=a; } }

Check this site: http://www.software.u-net.com/javaexam/

The answers to the questions are not the point: rather both the sense of community implicit in the sharing, and the instructional talents of the respondents, who posed their questions as unrestricted response (open-ended) prompts. To be sure, sharing may be a form of self-interest, because the more people who acquire the level of competence required for certification the better the communication across the industry. The people involved in these exchanges may wind up on the same design team.

53. With very minimal knowledge and study, I have taken practice pre-tests on-line for the A+ certification, the MCSE, and Web Developer, and, with correspondingly little difficulty, managed to flunk all of them. The experience drove home the most basic principle of IT industry certification: content counts! One cannot get by on interpreting verbal clues in prompts. You either know the "stuff" or you don't. And you must study—hard. Responses to Microsoft's 1998 salary survey revealed that those who earned the MCSE in the previous year spent an average of 216 hours preparing for their certification exams. The Microsoft Certified Trainers (MCTs), who must be recertified annually, spent an average of 222 hours preparing.

54. Given the global reach of IT certification, some examinations are available in languages other than English, but that depends on subject matter. Java, for example, is not written in Japanese, Spanish, or Russian. One might prompt an examinee to solve a Java problem using a language other than English, but without a modicum of English, the examinee cannot read or write the Java text. On the other hand, for example, the field of document imaging is symbol-dependent, not language-dependent, and CompTIA's examination for Document Imaging Architect is available in some languages other than English (and when it is not available in a local language, candidates have an extra 30 minutes to complete the test). In between are simulations which, as Microsoft notes, "are used more often in English exams," but can be incorporated into exams in "selected languages." When languages are "selected," they tend to be major. CompTIA's exams, for example, are offered in Spanish, German, French, Brazilian [Luso] Portuguese, Japanese, and both simplified and "traditional" [Mandarin] Chinese.

A global guild is sensitive to linguistic diversity, even when the technological supradialect of English is the language of its superstructure. From the perspective of traditional higher education, this awareness and concern with language environments should be one of the most attractive features of the information technology guild. It's not that certification requires bilingualism (though in many cases, it does), rather that the learning and assessment processes are linguistically inclusive. In the last half of the year 2000, Cisco's training partners, for example, are offering preparatory coursework for technical certifications in 19 languages other than English (see Appendix B).

55. The testing firms do *not* award the formal certifications. Rather, they report examination results to the vendors or industry associations that issue the documents of certification, and both vendors and industry associations may have requirements for certification beyond those of examination. Nor do the testing firms write the examinations or determine test content and specifications. The Computing Technology Industry Association (CompTIA), for example, maintains a board of Subject Matter Experts (SMEs) who write test objectives, new test items, and regularly conduct what's known in the psychometric trade as "content representativeness studies" to ensure that certification examinations are current with the state of knowledge and practice. Certification tests in the IT world are constantly being retired and replaced to meet the current state of vendor products and industry knowledge. As of January 2000, Microsoft had announced the retirement and replacement of 27 of its certification examinations. Compared to modal behavior in the world of higher education (the Graduate Record Examination Board's subject field test in Computer Science has not undergone a major content representativeness study since 1982!), these standards are rigorous.

56. I found a few exceptions to the firewall on test volume data, one of them perhaps inadvertent: a Prometric press release of March 10, 1999 indicating that, since the inception of the first IT industry certification a decade earlier, Prometric had delivered more than 2.1 million examinations for Novell alone. When a representative of Virtual University Enterprises estimated worldwide test volume for the entire industry in 1999 as 3 million (half outside the U.S.), the Prometric press release number did not appear outlandish.

57. Another exception came from the 8,500-member National Association of Communication Systems Engineers (NACSE). NACSE offers four generic certifications (two for technicians and two for "network specialists"). Its examinations, monitored by a board of standards, are delivered on-line by a small testing service firm called Web University, and administered by partner institutions (including colleges) which provide the computer labs and the proctors. As a non-profit organization, NASCE does not regard test volume data as proprietary information. Bob Kile, its Director, reported 1999 test volume in four "disciplines" as follows:

Network & Data Communications	6,400
Telecommunications	950
Web Issues	4,600
Programming	425

This distribution reflects larger industry patterns: networking certifications are more important than others as labor market entry and advancement points, and Web-related certifications provide entre to positions in a wide array of both commercial and non-profit organizations.

Beyond the Vendor: Generic IT Certifications

58. NACSE does not stand alone in the accounting of IT certifications other than those issued by vendors such as Microsoft, Cisco or Novell. The Computer Technology Industry Association (CompTIA) and the Institute for Certification of Computing Professionals (ICCP) are notable certifiers who have nothing to sell. As Christianson and Fajan note, their "vendor-neutral" certifications, "cover many products and concepts," are "developed by a wide range of experts in a particular field," and "encompass a [broad] range of skills and abilities."(p.528)

All vendor systems, for example, face the potential of crashes and "disaster recovery." Disaster recovery is, to use a conscious oxymoron, a generic specialization. Such specializations are similar to those in academic fields. So it is not surprising that we have an industry organization called the Disaster Recovery Institute (DRI) which has developed three levels of international certification in Business Continuity Planning. And with the increasing sophistication of hackers and virus originators, it was inevitable that the System Administration, Networking, and Security Institute (SANS) would launch a security certification program (including Web-based training), as it did in July 2000.

59. Another example of vendor/association collaboration is Novell's Certified Internet Professional (CIP), a credential developed in concert with the International Webmasters Association (IWA), the Association of Web Professionals, the Australian Web Developers, and the Association of Internet Professionals. There are five "tracks" in the program–Internet Business Strategist, Web Designer, Intranet Manager, Web Developer, and Internet Architect. Eleven (11) core courses support preparation on those tracks, and only one of the eleven, "Netware 4.11 Administration," is truly vendor-dependent (Novell). Separately, the IWA offers a Certified Web Professional designation available only to its 14,000 members (93 chapters in 31 countries, from Cambodia to Venezuela) . In addition to examination in at least

one of seven "Web disciplines" (the list is slightly different from that of the Novell CIP, in which IWA also participates), the CWP requires two years of qualifying job experience.

60. Beyond vendor/association collaboration lie joint vendor certifications. The most notable of these is the new "Certification Initiative for Enterprise Development," a cooperative undertaking of IBM, Novell, Oracle, Sun Microsystems, and the Sun-Netscape Alliance. This effort is described on Sun's Web site as "a multi-vendor Java technology training and certification initiative," and illustrates how a broad segment of the information technology industry recognizes and codifies the ties that bind. The key tie, in this case, is Java.

61. Increasingly, too, we find "cross-vendor recognized" examinations, a development that underscores the rationalizing trends in the industry, along with the competition for trained labor. Microsoft, for example, waives its networking examination requirement for those who are already certified by Novell, Banyan, or Sun as network engineers, specialists, or administrators. Novell waives *its* networking technologies exam requirement for those who already hold the MCSE (Microsoft) or Network+ (CompTIA) certifications. Intel exempts holders of CompTIA certifications (A+, Network+,and i-Net+) from its Technology Essentials examination (the relationship between the specific CompTIA certification and exemption depends on the track of the Intel certification for which one is a candidate). In the new Certification Initiative for Enterprise Development, the Sun Certified Programmer for the Java Platform examination is recognized by all corporate participants. In a way, these developments suggest that IT certifications ultimately prove to be generic. They are like piano concertos: practice one well, and you can learn the next one more easily.

Quality Assurance: Standards and the Accreditation of Certification Programs

62. The cross-vendor recognized examinations are a prelude to the adoption of industry-wide certification standards and accreditation, for, as one training Website noted, "certification has gone to new heights in confusion." In a response to the rapid expansion in the number of certifications, lack of uniform differentiation between levels of certification, and the desire to ensure that the certification is a meaningful credential, a Council on Computing Certification was formed in May 2000, and has distributed draft guidelines for both industry standards (including testing, currency of certification, continuing education/experience requirements, and support for practitioners) and accreditation of certification programs.

Unlike the construct of "program" in formal tertiary education, the IT certification "program" does *not* necessarily include an instructional provider. The proposed standards apply to the certifying agency, whether that be a corporate vendor (e.g. Microsoft), a broad-based industry association (e.g. CompTIA), an association of specialists (e.g. the Disaster Recovery Institute), or an educational institution that offers its own certifications (e.g. Learning Tree).

Under the proposed standards, all of these certifying organizations will be required to submit evidence of "a clearly stated domain [and sub-domains] of coverage" with identification of all

subsumed issues, tasks, and knowledge, as "developed by technically qualified individuals," and with a name for the certification that "accurately reflects this domain" (a kind of truth-in-labeling requirement). The certification itself must "require passing at least one exam" on which "75 percent or more of the identified sub-domains must be reflected" (a content-representativeness requirement). Furthermore, the certifying organization must review and update both the domain and examination content on at least an annual basis, and have in place a method for "assuring currency of skills." There are also requirements for support of certification candidates, modes of disseminating information about changes in requirements, and content of program materials. And under the proposed standards, a program cannot require membership in a specific organization as a prerequisite.

63. The proposed accreditation requirements seek to validate these standards for a "fully operational" program, and sort the certifications into levels. This last requirement is a very important step because it introduces an industry-wide "degree structure" that is currently practiced by only a few certifying agencies (Cisco, Compaq, IBM). The draft specifications for the three proposed levels of accreditation are worth quoting (in a slightly different format than presented by the Council on Computing Certification) because they demonstrate an alternative, performance-based way of thinking about a hierarchy of credentials:

> **Level I.** The domain must be limited to a single technology or skill area, and the certification candidate should be able to:
>
> - accomplish basic tasks in the domain without assistance;
> - solve common problems within the domain;
> - assist in more advanced tasks; and
> - Describe the technical structure of the domain.
>
> **Level II.** The domain must encompass either multiple technologies/skill areas or a complex single technology, and the certification candidate should be able to:
>
> - serve as a resource for others;
> - solve moderately complex problems without assistance; and
> - perform advanced tasks within the domain.
>
> **Level III.** The domain must encompass multiple technologies or skill areas, and the certification candidate should be able to:
>
> - troubleshoot complex problems;
> - confidently traverse the scope of the domain, from the most basic material to complex issues involving interfaces outside of the domain;
> - present "significance experience"; and
> - complete a hands-on assessment/lab exam/project.

In a way, these levels translate into analogues of Associate's, Bachelor's, and Master's degrees–at least in the context of one's major field of study. At the least, they are distinct benchmarks on a continuum of competence from novice to expert. But accreditation in the traditional postsecondary sector is focused on the *institution*, whereas these criteria derive from *student* learning and performance. Would our colleges and community colleges be willing to adopt this type of criterion in their accreditation procedures? As the IT certification preparation universe moves into the traditional tertiary sector, we may yet find out.

Coming Soon to a Campus Near You?

64. The traditional computer science major covers a number of topics that students can use in the course of preparing for IT certification, for example, Java programming, networks, and relational data bases. What about students who are *not* computer science majors? The limited background data available on certification-holders (only from Microsoft, and through its annual salary surveys) offer two complementary, common-sense trends that might guide traditional institutions of higher education that contemplate entering the certification preparation market in more comprehensive ways than fragmentary course offerings. First, the age distribution of certificate holders has moved decidedly lower: from 44 percent under the age of 35 in 1996 to 58 percent in 1998. The second change is more dramatic: the proportion holding less than a bachelor's degree jumped from 19 to 37 percent in the same period. The potential for helping 20-something students complete both degrees and certification is obvious—provided that institutions of higher education are willing to place certification in the same category as any other program of credit-by-examination, and to adjust residency requirements accordingly.

65. Where and how has the IT certification package been translated into the standard currency of the credit system with or without the intervention of ACE's Credit Service? Our evidence is anecdotal, but the large-scale anecdotes such as Pima Community College District's arrangement with Novell, Microsoft and other vendors illustrates what can transpire. Pima has become a *de facto* accreditation agency for 170 sites (including its own) at which preparatory instruction for certification is delivered. Called the ITCAP (Information Technology College Accreditation Program) network, and existing as a separate corporation, it offers students at approved centers the opportunity to turn certification preparation into degree-additive credits through challenge examinations. These examinations were developed by Pima faculty and are scored by Pima faculty. They are not Novell exams or Microsoft exams, but they will get you college credit. Between the late fall of 1997 and May 2000, and excluding desktop applications, over 12,000 challenge examinations had been taken under the ITCAP program. Tellingly, though, and in the words of a Pima administrator, "to the best of our knowledge, no student has continued to degree [Associate's] completion."

66. A different version of this type of arrangement is the integration of multiple certifications into a bachelor's degree program. Regents College of Albany, NY, a non-profit specializing in distance education degree programs and with a current enrollment of about 17,000, has teamed with Microsoft, CompTIA, and Prometric to offer a BS in Computer Information Science with

credit-by-certification-exams (vendor and vendor-neutral) at the core. The program is open only to those who either hold an associate's degree or have previously earned 60 college credits. This is a very promising mechanism both to facilitate transfer and to encourage long-term non-completers (who have accounted for eight percent of recent cohorts of traditional-age college entrants) to finish their degrees.

67. A third version involves colleges and community colleges purchasing complete packages of on-line curricula from commercial developers, and placing the stamp of their own certifications on completion of the package. The University of Colorado at Denver, for example, chose to take clusters of network-oriented courses developed and delivered by WestNet, and offer its students a "Certificate in Networking." This is a convenient type of relationship for many institutions of higher education faced with enrollment pressures that build at certain joints of the organization: it allows the leveraging of instructional power, accommodation of greater numbers, and flexibility in place and time of course delivery.

68. Lastly, some four-year institutions, both in the United States and other countries, have become formal training-partners of the major vendors, offering course work through continuing education and special divisions. Both Louisiana State University and the University of Akron, for example, are Novell partners, as is the École Normale Supérieure de Lyon in France. And a special unit of the prestigious computer science department at Moscow State University, REDlab, offers both Cisco and Sun certification course work. One finds these cases only on the web sites of the vendors. Whether these instructional activities will move from organizational peripheries to the mainstream of curricular offerings is an open question, one worth tracking.

69. The complex cross-currents of certification preparation course work in the traditional postsecondary universe are revealed in Microsoft's Authorized Academic Training Provider (AATP) program. Microsoft distinguishes between its Certified Technical Education Centers, commercial firms such as Global Knowledge or Azlan, and accredited educational institutions, both high schools (see section #73 below) and postsecondary providers. To become an AATP, an accredited school or college must agree to deliver Microsoft-approved courseware with instructors who have passed Microsoft Certified Professional examinations on the topics of instruction, and with hardware and facilities that meet Microsoft's requirements (and that are subject to inspection). In these dimensions of the relationship, the vendor, in effect, is acting as a second accrediting agency.

But there are two other aspects of the dynamic that transcend traditional accrediting standards: first, that the AATP "submit reports on course attendance," and second, that the college or trade school or high school agrees to cap at 12 per week the number of hours of instruction for any certification preparation course. The reports on course attendance may provide the kind of data on preparation for certification that has been so elusive to date. The 12-hour cap is more than a gesture of respect for the rest of the institution's curriculum: it keeps the IT certification program at the margins. The cap also fits neatly into the learning rhythms of continuing education students. Under these conditions, who has signed on?

70. Table 7, derived from a state-by-state listing on Microsoft's Web site, indicates the number AATP agreements in effect in different sectors of U.S. education as of August 2000. The comments are mandatory.

Table 7.—Distribution of Microsoft Authorized Academic Training Providers (AATPs), by Level and Control of Institution, Including Branch Campuses, August 2000

Category	Number	Comment
4-Year Public and Not for Profit	142	Approximately one-third are continuing education units
4-Year For-Profit	42	Two-thirds are campuses of the University of Phoenix
2-Year Public and Not for Profit	298	Includes multiple campuses of large community college districts such as Houston and Allegheny (Pittsburgh)
2-Year For-Profit	103	Includes multiple campuses of Heald, Herzing, and others
Indeterminable Postsecondary Status	39	Not listed in Barbett and Lin (1998) nor otherwise located.
High Schools	129	More than half are technical/ vocational high schools.

There is no doubt that the postsecondary universe of AATPs is dominated by sub-baccalaureate institutions, at least in the United States (in contrast, albeit in a smaller universe, eight of the ten AATPs in Argentina are universities). And while there are some distinguished institutions in the 4-year collection, most of these are present only through continuing or extended education units. This combination suggests that most of the pre-certification courseware will remain at the periphery of higher education. The potential for growth in secondary education, however, is another story.

Building a Pipeline

71. Pre-collegiate and threshold certifications are a growing phenomenon. Consider, for example, the NetPrep program: sponsored by 3Com, with a curriculum developed by WestNet Learning, and blessed with certifications from the National Association of Communication Systems Engineers (NACSE). NetPrep offers four packages of courses, at different levels, to

both high schools and colleges, with accompanying examinations for junior-type certifications. The threshold high school courses on networking fundamentals and LANS will get you a NACSE Student Technical Certificate of Achievement. Add courses in Wide-Area-Networks (WANS) and Networking Architecture, pass the exams, and you are dubbed a Student Network Technician. The college-level packages are the same as those offered to NACSE member-candidates for two levels of Network Specialist certification, Associate and Senior. But in all these cases, school and college, students must join the organization. This approach builds a pipeline to the guild.

72. The Cisco Networking Academy, claiming nearly 3200 sites in 59 countries, is a four-semester program in which students can apply credits toward the Cisco Certified Network Associate credential. Contrary to a popular belief, the academies are not confined to schools. Of 329 Academy locations in California, for example, seven are at 4-year colleges, 56 are at community colleges, and eight are at secular institutions. It is difficult to determine total enrollment and retention in the Cisco Academy programs, but some of the sites profiled on Cisco's website provide very indirect evidence: 50 students at Madison Area Technical College in Wisconsin, 50 at Oakland (Calif.) Technical High School. Even though this program is vendor-specific, there is no question that students acquire generic industry knowledge of such key elements of networks as protocols, configurations, filters, and segmentation.

73. We noted that the Microsoft AATP program included 129 high schools as of August 2000 (see table 7). Some of these high school programs were not born yesterday. Wyoming started in 1995, and by 1998 had 250 students in eleven regular regional high schools enrolled in the likes of generic Networking Essentials, Visual Basic programming, and vendor-specific Windows NT Server software courses. A tech-prep articulation program has been worked out with two of the state's community colleges, and a dual-enrollment agreement can net the student up to 21 college credits (including accounting and business mathematics in addition to the IT certification preparation courses). Math through pre-calculus is required. There are no junior certifications here. Instead, the student is given momentum on the path to certification. What is more notable about the AATP high school program, though, is the required teacher training and certification. When secondary school teachers must pass IT subject examinations and are challenged to be certified as IT trainers, guild knowledge becomes resident at a very local level.

74. The Wings-21 program in Nebraska illustrates a different type of sponsorship and approach. It was developed by a nonprofit consortium of business, government agencies, and schools to introduce students to IT careers starting with a required Pathway-21 Course in grade nine. Following this experience, 14 participating high schools teach Cisco technology, and area businesses provide internships, for example, working with teachers on U.S.West projects in application programming and database development. There is no specific pre-certification here, and the vendor role is secondary to opening up paths to programming, multimedia, and business applications. The metaphor of the "pipeline" is derived from fluid mechanics, and envisions a closed space and an inevitable direction. The IT world doesn't always work in such inexorable ways, so the options inherent in the "path" approach of Wings-21are attractive.

Summary: the New Global Guild

So what is it? What is it not? And having learned something about it, can we say what it means for traditional higher education.

75. *First and foremost, the IT certification universe is an international guild that lies beyond the ken or control of governments.* The medieval guild engaged in a form of licensure that was designed to facilitate and control the *flow* of labor and the *level* of knowledge/skills necessary to practice a particular trade at the same time that it sought to protect its members from unwanted intrusions and rivals (Le Goff, 1980; White, 1952). In some contrast, IT Industry certification is a form of guild behavior that seeks to *expand* the labor pool as well as its flow. Its closest labor market analogue in the licensure of allied health field specialties–licensure that is largely borderless and competency-based.

Of course, certification is not a license. The practice of "Webmaster," for example, does not affect human health or safety, so the certificate for such employment is neither regulated nor monitored by public authorities (as is the practice of nursing).

76. *Second, because the guild lies beyond governmental oversight, we have little idea of who is involved in certification and where.* There are no unduplicated head-counts, there are no central registries, there are no ledgers of providers or instructors. Even in the ITCAP program run by a subsidiary corporation of the Pima Community College District in Arizona, 47 percent of students enrolled in the fall semester, 1999 did not report race/ethnicity and 10 percent did not report gender (age was another story: 75 percent were 30 or older). The closest we come to an accounting is in the third-party testing centers, and because those parties are in competition, whatever information they possess they consider confidential. In fact, the third-party testing centers collect very little data: in the words of a VUE representative: "only...what is necessary to register a candidate for an exam —name and contact information."

77. *Third, at the center of this transnational postsecondary system of teaching, learning, and credentialing is not the local institution but the global student.* We can call the system "postsecondary" because the level of reading, reasoning, and communication skills necessary to comprehend and apply its content assumes secondary level education in most countries. It is the student who, on entering that system, negotiates different sources and ways of learning without being bound to an institution in a given place in a given country. The e-mail addresses of inquirers and respondents in the examination preparation chat-rooms of brainbuzz.com speak eloquently to a worldwide community studying together. Indeed, what distinguishes this system most from the academic world is that it operates the same way, with the same signals to students, and with the same meanings —though in different languages —in Montreal, Manaus, Munich, Mogadishu, Manila, Moscow, and Milwaukee (see Appendix B).

78. *Fourth, the IT guild has brought competency-based education and performance assessment to a status they have never enjoyed within traditional higher education.* The guild has implemented, in effect, many of the reforms espoused within the academy in the 1970s and 1980s. In all countries now, this new system cares most about your learning, your demonstrable competence, and your potential in the IT workforce. It sets accessible criterion-referenced standards of performance and is confident enough to turn the judgment of performance over to competent third parties. Where you come from, what you look like, where you went to school, how many credits and what degrees you earned, your SAT or ACT scores —these matters are not even on the radar screen of the IT certification guild.

79. *Fifth, the system is not higher education.* It is not in the business of helping adolescents become adults, of providing multidimensional education, or of teaching the literacy and numeracy skills necessary to manipulate its own knowledge universe. It is a two-dimensional system, and, for that reason, is not higher education and does not pretend to be. To the extent that formal coursework is part of its offerings, the IT guild's instructors are teachers, not university faculty. They are a different kind of workforce.

Industry certifications, whether in information technology or other fields, replace neither experience nor degrees. Nor do they pretend to represent an assessment of the full range and depth of knowledge, skills, or potential contribution to organizational productivity. Instead, we might say, the certification serves to *augment* experience and traditional credentials. For their part, employers do not *require* certification, rather reward it. Microsoft's and Novell's salary surveys consistently evidence a post-certification premium of 4-14 percent in the combination of base pay plus bonuses.

80. Students know this. From their demand-side behavior, the search for certifications other than academic degrees is seen as yielding mobility in "work life." Unlike the period dominated by the guilds, let alone most of the 20th century, labor market experience is no longer linear or unidimensional. People assemble valises of special knowledge and skills, apply them in different work-organization contexts, and modify them by (1) personal predilection, (2) personal perception of potential "work life" paths, and (3) labor market change. With each of these modifications or enhancements, we have come to realize, work life mobility demands the transparent and portable evidence of a certification. We may not be tracking the phenomena well, but the data cited earlier in this monograph suggest that considerable numbers of students are finding these certifications and the "secular" entities that provide the preparation.

Information Needs for National Planning Everywhere

This parallel universe has sufficient resources and momentum to go its own way. To the extent to which there are occasional interactions between its secular providers and the traditional postsecondary and tertiary sectors in various countries, we will catch glimpses of its scope and dynamics, and may be stimulated to adapt some of its performance assessment processes. But there is no question that the public interest in a 100 nations would be well served if we

possessed at least the same information about certification candidates and their backgrounds, enrollments, and awards, and the same information about providers (the "training partners") as we do for the universe we know. As much as they are appreciated, we can not rely on surveys of certificate recipients producing 20 percent response rates (from small samples to begin with) from one major vendor (Microsoft) to tell us what is transpiring and for whom. Nor can we rely on the country-distribution of one highly-elite population, the roughly 5,000 Certified Cisco Internetworking Experts (CCIEs) as of July 2000 (see Appendix B) to tell us *where* it is happening. All nations must plan and budget for the provision of postsecondary schooling. If a significant number of individuals follow paths that use the parallel universe, their actions affect planning and budgeting, and because the universe is transnational its information is analogous to that necessary for international trade. No one government can require or collect this information. The effort might be coordinated through an international organization, and with the voluntary cooperation of the IT guild, which might establish a central registry of certified individuals, with enough information on educational and demographic backgrounds to help policy-makers map the full dynamics of global postsecondary education.

This information would have a considerable impact on our assumptions concerning the capacity of the system of postcompulsory schooling, and the way we plan for future enrollments. By national policy, and beyond the increases that would occur naturally by demographic dynamics, the United States has invited about two million new students into the higher education sector. These people—and others—will go to school in very different ways than was true as recently as 1990. Yet we have not factored in multi-institutional attendance and the secular providers into our calculations at all. We talk glibly about "tsunamis" for which we are unprepared, rush to open branch campuses, put existing campuses on 24/7 schedules, and flagellate ourselves when students enroll for only a few courses and then disappear. We may turn around some day to find that these students have "disappeared" into the world of the secular providers. But until the parallel universe becomes part of national accounting systems and until we learn to follow the student—and not the institution—we'll never know.

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Appendix A:

Three Interacting Platforms

For readers who would like a very concise outline, let us aggregate the observations made above, and put them in an order that reflects the emergence of the IT industry certification guild. There is nothing linear about the process. There are three distinct platforms in this development that are constantly interacting.

Platform I: Establishing the Certification of Competence

- *Vendors* (international corporations such as Microsoft, Novell, SAP, Sun, Oracle, Cisco and others) establish standards for performance with their product-systems. They ultimately determine whether an individual meets those standards.
- Acting individually, each vendor constructs a set of examinations that signals a comprehensive competence. A certificate is to be awarded to individuals who pass the required examinations. Some certificates require performance assessments and industry experience in addition to the tests. The certificate is given a discrete vendor-based name, e.g. Microsoft Certified Systems Engineer.
- Within fields covered by a certificate, vendors establish sub-specialty certificates, and some create hierarchies of certifications analogous to hierarchies of academic degrees.
- Vendors recognize that their product-systems share a great deal, and, in practical circumstances, interact. Networks are a good example of a territory in which this commonality and interaction can be observed. Some standards for performance, then, become generic. Some vendors accept the examinations or certifications of other vendors as part of their own certification processes.
- *Industry Associations*, often consisting of sub-field specialists, develop analogous standards, examinations, and procedures of certification. These are *not* vendor specific. Where there are a number of industry associations in the same sub-field, certifications may overlap. The various Webmaster certifications are a good example.
- The vendors and the industry associations are the only recognized certifying authorities, and they insure a constant feedback loop from the instructional and testing platforms.
- For the industry associations, vendors, and other employers of IT professionals, the values of the certification lie in (a) guaranteed currency of knowledge, (b) intellectual and skills leadership of certified employees, (c) less down-time and greater efficiency, particularly in a rapidly-changing technological environment, and (d) where applicable, staff interactions with other parts of the industry through the guild, hence, greater organizational knowledge.

Platform II: Providing Opportunity-to-Learn

- The vendors recognize that anyone–in any nation–should have the opportunity to acquire the competence and knowledge required to pass their examinations and qualify for

certification. They thus develop curricula and the materials/technology for delivery of those curricula–and in many languages. To be sure, providing these opportunities to learn also creates a skilled labor pool.

- Some vendors function as schools themselves. They offer traditional classroom instruction at many locations around the world. They certify instructors, rent facilities, and charge tuition for the course work. They also provide courseware in CD-ROM format and on-line from strategically located servers. Tuition is charged for those modes of learning/instruction as well.
- Most vendors, however, link with commercial and training companies. These "training partners" must first be reviewed and authorized by the vendor as knowledgeable in the curriculum, skilled in instructional delivery, and possessing appropriate capacity to accommodate various types and volumes of enrollments in their service area. Training partners can also include traditional higher education institutions and other non-profit entities, though these are more loosely-coupled to the vendor. Despite review and authorization, the quality of training may vary widely.
- *Industry associations* follow suit, linking with "training partners" to provide the opportunity-to-learn.
- Some training partners offer their own certifications in the same fields as those offered by the vendors, but in a more generic, vendor-neutral form. These generic forms, like those of the industry associations, resemble college majors. Network Administration is a good example.
- On-line education providers that are *not* official "training partners" sell support tutorials and self-study materials on specific topics in the certification sequences, and others provide settings for learning exchanges between those studying for examinations and those who have already passed through the gates of certification. The industry recognizes that, in a world of lifetime learners, preparation for certification does not necessarily require formal course work.

Platform 3: Testing and the Award of Certifications

- Both vendors and industry associations develop their own examinations for each portion of knowledge/competence required for a specific certification. Public statements of expected competencies, along with practice examinations, are available on-line.
- The examinations take many forms, and some are available in languages other than English. Some are computer-adaptive, some are based on case studies, some involve simulations, and some are Item Response Theory (IRT)-based multiple choice. Every vendor or industry association that develops these tests retains a staff of testing experts.
- Examinations are under constant review for content. They are frequently "retired" and replaced so that they reflect contemporary knowledge demands.
- The vendor or industry association determines the passing (cut) score on the examinations.
- A minor industry has grown up around IT certification examinations: test-preparation manuals, special test-prep classes and CD-ROM based practice tests. These are signs of

maturing credentials, but also expected in an industry that encourages existing employees to seek certification.

- The examinations are administered either by vendors themselves or by independent testing companies. There are at least three major global testing firms on which the information technology and telecommunications industries principally rely to conduct examinations. Collectively, these firms operate 5,000 testing centers in 140 countries.
- "Candidates" for certification submit examination scores and other requested material to the vendor or industry association, which then awards the certification.
- Most certifications must be either renewed or maintained by continuing education, seminars, and/or examination.

Appendix B:

Two Indicators of Global Reach in a Cisco Certification and in the Languages of Course Offerings by Cisco Training Partners

Worldwide Distribution of Certified Cisco Internetworking Experts (CCIEs) as of July 31, 2000

North America		2488
U.S.	2299	
Canada	145	
Mexico	44	
South America		67
Europe		1571
Belgium	154	
France	126	
Germany	282	
Netherlands	76	
Russia	48	
Spain	44	
Sweden	65	
U.K.	389	
Africa		83
Middle East		20
Pacific Rim		765
Australia	184	
China	108	
Japan	224	
Singapore	55	
Other:		2
TOTAL:		4,996

Languages of Course Offerings by Cisco Training Partners, July 1, 2000 through Dec. 31, 2000

Language	Courses	Offerings
Croatian	1	2
Czech	3	5
Danish	7	41
Dutch	6	136
Finnish	2	5
French	13	238
German	23	702
Greek	3	10
Indonesian	5	6
Italian	10	99
Japanese	3	12
Mandarin	7	12
Norwegian	2	4
Polish	5	23
Portuguese	15	67
Russian	5	17
Spanish	10	78
Swedish	2	8
Turkish	3	8

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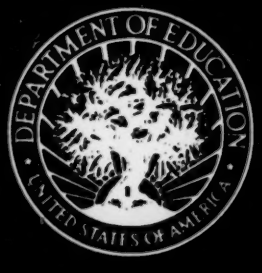

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